Measuring Aid Effectively in Tests of Aid Effectiveness[§]

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Abstract

In the extensive empirical literature on aid effectiveness, aid is always measured as a share of GDP. However, measuring aid in real dollars *per capita* is also consistent with standard growth theory. As the theory would suggest, the choice of denominator makes an enormous difference to the sign and significance of coefficients on aid variables in regressions such as those in Burnside and Dollar (2000).

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1. Introduction

Since the publication of Burnside and Dollar (2000) (henceforth B&D) there has been a very lively debate on the factors that determine the effectiveness of foreign aid, and in particular on the role played by recipient government policy and institutional quality. Several recent papers present evidence in support of the original B&D result, that the beneficial effects of aid are largely confined to countries with healthy policy environments; these papers include Collier and Dehn (2001) and Burnside and Dollar (2004). B&D is extensively cited in the academic literature and has had an enormous impact on policy-makers (*The Economist*, 01.13.2007, page 67). Two sets of papers challenge the B&D result, but for very different reasons. On the one hand are those such as Easterly *et al*. (2004), who argue that there is not yet any robust evidence that aid promotes economic growth, even in “good” policy environments. On the other hand are authors such as Dalgaard and Hansen (2001), who contend that there is clear evidence that aid promotes growth (albeit with diminishing returns), regardless of the policy environment. McGillivray *et al*. (2006) provide an overview of the wide range of results to be found in recent papers, and Doucouliagos and Paldam (2006) conduct a meta-analysis of these results.

A large part of the debate revolves around the effect of changes in sample size and estimation technique on aid coefficients in regressions of *per capita* GDP growth rates on the lagged level of *per capita* GDP and a set of conditioning variables, usually using panel data for a set of developing countries. A key feature of these regression equations is that they are non-linear, since they include terms in aid interacted with indices of good policy or institutional quality. In the next section we show that the results of aid-growth regressions are sensitive to yet another permutation, that is, changing the denominator used to scale the aid variable. In the final section we interpret this finding, and discuss its implications for future research in this area.

2. Empirics

Our empirical analysis uses B&D as a benchmark. We employ the same panel data set as B&D, and use the same estimation techniques to replicate their results.[1] The only change we make is to the way that aid is measured. B&D – and every other empirical paper we are aware of – measure

[1] We do not replicate all the regressions in B&D, but focus on their basic model, fitted using OLS, and on their preferred model excluding outliers; we exclude the same five observations as B&D. There is a small but statistically significant negative correlation between aid *per capita* and GDP *per capita* (r = -0.18), and it is possible that endogeneity biases our *per capita* aid coefficients downwards. If so, the results presented below understate our case.

aid as a fraction of recipient GDP; we measure aid in real PPP-adjusted international dollars *per capita*. We construct this measure by scaling the B&D aid measure for country *i* in period *t* by the average value of *i*'s real *per capita* GDP in international dollars during period *t*. The *per capita* GDP data are taken from the same version of the Penn World Tables as that used in B&D.

Our results are presented in Tables 1-2 alongside the original B&D results. In all cases, the dependent variable is the percentage rate of growth of the real international dollar value of *per capita* GDP in country *i* over period *t*. The set of regressors includes the initial (log) level of *per capita* GDP plus a range of conditioning variables, including fixed time effects, a measure of ethnic fractionalization, the number of political assassinations *per capita*, a measure of institutional quality, the lagged ratio of M2 to GDP and region dummies for Sub-Saharan Africa and East Asia. All of the regressions also include the B&D measure of policy quality (a weighted average of figures for the budget balance, inflation and the Sachs-Warner openness index) and a measure of aid: either aid as a fraction of GDP or aid *per capita* in international dollars. The correlation between aid *per capita* and aid as a share of GDP is 0.73: the two series are highly, but far from perfectly, correlated. In Table 1, which corresponds to Table 4 (columns 3-4) in B&D, this basic regression specification is complemented by an expanded model that includes the aid measure interacted with policy and the square of the aid measure interacted with policy. In Table 2, which corresponds to Table 4 (column 5) in B&D, the squared aid term is absent, but a number of outlier observations are excluded from the sample.

Tables 1-2 here

If we measure aid as a fraction of GDP then it is statistically significant only when interacted with the policy variable; this is the original B&D result. In the B&D model in Table 1, there is a significant positive coefficient on aid interacted with policy and a significant negative coefficient on aid squared interacted with policy, suggesting that aid is effective (with decreasing returns) in good policy environments. In poor policy environments, the effect of aid is negligible. When the outliers are removed (Table 2), the squared aid term is redundant but the results are otherwise very similar: unless aid is interacted with policy, it does not appear to be a significant explanatory variable.

The two tables show that if aid is measured differently then the results are completely different. Aid *per capita* does have a significant positive coefficient, even in the absence of any interaction terms. Our estimate of the coefficient on aid *per capita* is around, 0.02 implying that a

$100 increase in aid *per capita* would raise the rate of *per capita* economic growth by two percentage points. When aid *per capita* interaction terms are included in Table 1, they too have significant coefficients, but with the opposite signs to those in B&D! (The fitted coefficients on the interaction terms are very much smaller than in B&D, but this is the result of an arbitrary scaling of *per capita* aid.) The aid-policy interaction term in Table 2 is not significant at all. If the *per capita* aid results had predated B&D, one might have concluded that aid does have a significant impact on growth, even in countries with poor policy regimes.

3. Interpretation and Conclusion

The sign and significance of coefficients on foreign aid variables in cross-country panel growth regressions is very sensitive to the way that aid is measured. Including terms in aid *per capita* instead of aid as a fraction of GDP completely changes the results. This discrepancy casts doubt on some traditional interpretations of aid-growth regressions.

Neither the B&D model nor our alternative is the uniquely "right" way of specifying an aid-growth regression. A theoretical model of growth can be expressed equally well either in terms of aid *per capita* or in terms of aid as a fraction of output (as shown in the Appendix), although of course this choice will affect the theoretical derivative of growth with respect to aid, however aid is measured. One ought to be able to apply both versions of the theoretical model to the data and produce two sets of empirical results that are both consistent with the theory, and therefore with each other. But the functional forms of existing "benchmark" aid-growth regressions are not explicitly derived from theory, so this is not possible, and so the discrepancies that we have uncovered are still unresolved. Traditionally, theoretical models of aid and growth, which are few in number, measure aid *per capita* but empirical models measure aid as a fraction of GDP. Papers incorporating both theoretical and empirical models (for example, Dalgaard *et al*., 2004) do not deviate from these conventions, switching from one aid measure to the other without explicit comment. There is no paper that makes an explicit link between the cross-partial derivatives of a theoretical growth model and the interaction terms in a corresponding growth regression.

Bridging the gap between theory and empirics is an important area for future research. Even the simplest theoretical models throw up functional forms for growth regressions that differ according to the way that aid is measured. For example (as shown in the Appendix), when an aid variable is added to the economy's resource constraint in a standard OLG model, the equation of motion for *per capita* output is not log-linear. Moreover, the form that the non-linearity takes – and hence also the signs on interaction terms in a corresponding growth regression – vary according to whether aid is expressed as a fraction of output or in *per capita* terms. An additional layer of complexity will arise if the return to aid-funded investment is allowed to depend on some exogenous factor such as institutional quality. We must await a comprehensive and fully specified growth theory – one that pays full attention to tedious questions about appropriate functional form – for an explanation of the discrepancies revealed in this paper.

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Table 1: B&D Regressions Compared with *Per Capita* Aid Regressions

Standard errors are in parentheses.

*** indicates significance at the 5% level; * indicates significance at the 10% level.*

	B&D		aid *per capita*		B&D		aid *per capita*	
	coeff.	(s.e.)	coeff.	(s.e.)	coeff.	(s.e.)	coeff.	(s.e.)
Initial GDP	-0.61	(0.56)	-0.73	(0.49)	-0.56	(0.56)	-0.78	(0.50)
Ethnic Fractionalisation	-0.54	(0.72)	-0.29	(0.74)	-0.42	(0.73)	-0.38	(0.75)
Assassinations	-0.44	(0.26)*	-0.44	(0.27)*	-0.45	(0.26)*	-0.45	(0.27)*
Ethnic × Assass.	0.82	(0.44)*	0.84	(0.44)*	0.80	(0.44)*	0.85	(0.44)*
Institutional quality	0.64	(0.17)**	0.74	(0.17)**	0.67	(0.17)**	0.70	(0.17)**
M2/GDP	0.014	(0.013)	0.002	(0.010)	0.016	(0.014)	-0.002	(0.010)
Sub-Saharan Africa dummy	-1.60	(0.73)**	-2.16	(0.67)**	-1.84	(0.74)**	-2.10	(0.67)**
East Asia dummy	0.91	(0.54)*	1.11	(0.57)**	1.20	(0.58)**	0.91	(0.60)
Policy	1.00	(0.14)**	0.95	(0.14)**	0.78	(0.20)**	1.14	(0.23)**
Aid	0.03	(0.12)	0.022	(0.01)**	0.05	(0.12)	0.02	(0.01)*
Aid × policy					0.20	(0.09)**	-0.02	(0.01)*
Aid^2 ×policy ÷ 100					-1.9	(0.8)**	0.02	(0.01)*
R^2	0.392		0.410		0.398		0.417	
N	275		275		275		275	

Table 2: B&D Regressions Compared with *Per Capita* Aid Regressions (Restricted Sample)

Standard errors are in parentheses.

*** indicates significance at the 5% level; * indicates significance at the 10% level.*

	B&D		aid *per capita*	
	coeff.	(s.e.)	coeff.	(s.e.)
Initial GDP	-0.60	(0.57)	-0.85	(0.49)*
Ethnic Fractionalisation	-0.42	(0.72)	-0.25	(0.75)
Assassinations	-0.45	(0.26)*	-0.45	(0.27)*
Ethnic × Assass.	0.79	(0.44)*	0.85	(0.44)*
Institutional quality	0.69	(0.17)**	0.79	(0.17)**
M2/GDP	0.012	(0.014)	0.000	(0.02)
Sub-Saharan Africa dummy	-1.87	(0.75)**	-2.35	(0.69)**
East Asia dummy	1.31	(0.58)**	1.22	(0.59)**
Policy	0.71	(0.19)**	0.86	(0.20)**
Aid	-0.021	(0.16)	0.027	(0.01)**
Aid × policy	0.19	(0.07)**	0.002	(0.005)
R^2	0.394		0.410	
N	270		270	

Appendix

Take a simple textbook OLG model (as for example in Romer, 1996, chapter 2), in which the resource constraint is

$$k_{t+1} = [s_t \cdot w_t] / [1 + n] \quad (1)$$

where k_t is the capital-labor ratio in period t, s_t the household savings rate, n the rate of growth of the working population and w_t the equilibrium wage rate. Assuming a logarithmic utility function and a Cobb-Douglas production function with a fixed technology, we can derive an equation of motion for output per worker:

$$y_{t+1} = [\beta \cdot y_t]^{\alpha} \quad (2)$$

where $\beta = [1 - \alpha] / \{[1 + n] \cdot [2 + \rho]\}$, α representing the Cobb-Douglas parameter and ρ the rate of impatience. This equation implies a growth regression of the form:

$$\Delta \ln(y_{t+1}) = \alpha \cdot \ln(\beta) - [1 - \alpha] \cdot \ln(y_t) \quad (3)$$

In empirical growth regressions, the constant β is replaced by a range of variables capturing the determinants of factor productivity, for example, the conditioning variables in Tables 1-2. We can easily add an aid term to equation (1):

$$k_{t+1} = [s_t \cdot w_t + x_t] / [1 + n] \quad (4)$$

where x_t is to be interpreted as an exogenous resource inflow per worker. Equation (2) becomes:

$$y_{t+1} = \{\beta \cdot y_t + x_t / [1 + n]\}^{\alpha} \quad (5)$$

However, it is also possible to rewrite this equation in terms of aid as a fraction of output. Let $z_t = x_t / y_t$; then we have:

$$y_{t+1} = \{[\beta + z_t / [1 + n]] \cdot y_t \}^{\alpha} \quad (6)$$

In neither equation (5) nor equation (6) is y_{t+1} a log-linear function of β, y_t and aid. Also, the form of non-linearity in equation (5) is different from the one in equation (6). In general, regression equations incorporating aid *per capita* should not exhibit the same non-linearities as ones incorporating aid as a fraction of GDP.

Reference

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